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Research on the port competitiveness of ports participating in the Belt and Road Initiative

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Research on the Port Competitiveness of ports participating in the Belt and Road Initiative

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Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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List of Abbreviations

BRI	Belt and Road Initiative
TEU	Twenty Foot Equivalent
GDP	Gross Domestic Production
MSR	Maritime Silk Road
AIIB	Asian Infrastructure Investment Bank

Abstract

Belt and Road Initiative (BRI) has been introduced by President Xi in 2013, which includes major infrastructure projects in approximately 80 countries and including a project called maritime silk road which would be the major discussion in this paper. We would focus on ongoing and finished BRI related projects with a focus on maritime based projects in major regions which are heavily involved in BRI investments and projects including Asia, Europe, Middle East and Africa. A sample of ports (Port of Singapore, Port of Rotterdam, Port of Antwerp, Port of Colombo, Port of Gwadar, Port of Hong Kong, Port of Piraeus and Port Klang) are chosen to be analysed using factor analysis by using 3 main indicators (infrastructure, Operation scale and Economic Indicators) and 9 more detailed indicators to come out with a conclusion of which port is more competitive in the region, and which ports require higher importance in terms of higher capital injection as they have their own advantages but still lack the basic infrastructures required for improved maritime trade. A number of suggestions regarding trade cooperation in the region and importance of development of ports based on the conclusion found on the ranking of ports.

Keywords: Belt and Road Initiative; BRI; port infrastructure; Factor Analysis; port policy

1. Introduction

1.1 Research background and significance

A new establishment of regional cooperation model was introduced by Chinese President Xi in September 2013, and eventually it was approved by the state council in March 2015 with detailed plans of the Belt and Road Initiative (BRI) ((Siu et al, 2018). In terms of geography, BRI consist of three main routes, he first one being from China through Central Asia and Russia and Europe through the Baltic Sea, the second one being from China through Central Asia and West Asia to the Persian Gulf and Mediterranean Sea, and the third being from China through South East Asia and South Asia to the Indian Ocean (Huang, 2016). Besides that, a Maritime Silk Road (MSR) that starts from ports in China's coastal city through South China Sea to the Indian Ocean, further linked to Africa and Europe, corridors connecting to neighbouring countries such as Pakistan, Bangladesh, India and Myanmar (Huang, 2016). BRI is expected to be built around 60 countries, amounting to 64% of global population.

To finance this project, China has created a Silk Road Fund amounting to USD$40 billion, which is intended to serve as a sovereign wealth fund, two financial institutions including Asian Infrastructure Investment Bank (AIIB) and New Development Bank (NDB). China is expected to spend a total of around US$4 trillion in BRI countries throughout the whole project (The Economist, 2017). The objectives of BRI have been widely discussed academically with vastly different point of views. Huang, 2016 and Cheng 2016 mentioned the main purpose of establishing BRI is to sustain China's economic growth. China's GDP grew around 9.6% annually from 1980 to 2015, and GDP growth has been eventually slowing

down from 7.7% to 7.4% and eventually 6.9% starting from 2013, some argued that since China was very reliant on exports and foreign direct investments, a drop of demand in the global market may have partially caused this phenomenon. Zhou et al., 2011 mentioned the importance of China injected 4 trillion yuan to their economy after the global financial crisis in 2008, where 1.5 trillion was allocated to public infrastructures, 1 trillion to reconstruction works on Sichuan where a major earthquake occurred in May 2008 and the remaining was made as welfare. Yu et al, 2011 used a granger causality test to examine the relationship between investments in transportation and growth in regional development from 1978-2008, they concluded varying investments in transportation in eastern coastal cities and lower western China made development and productivity in coastal cities more advanced compared to their peers. Song & Mi, 2016 used a similar granger causality test and concluded that investments in port infrastructure in China from 1999 to 2009 had significant importance in economic development of coastal cities and their respective hinterland, long term GDP growth and industrialization of the cities had improved as port investments was implemented. Moreover, Song & Geenhuizen, 2014 also applied a production function of output elasticity of port infrastructure and concluded the importance of investments in both seaport and inland port infrastructure to help improve regional economic impact of China and examined the spill over effects the investments had to neighbouring provinces, policies from both central and provincial government plays a great role in economic growth. China's economic growth has been highly tied to an export-oriented economy which has benefited from huge transportation infrastructure investments from the past. BRI is a similar project with initial infrastructure investment objectives which aims to

replicate economic developments on a much bigger scale. China has heavily invested in port infrastructures throughout the years

and as of 2018, 7 China's port are included in top 10 container ports of the world in terms of volume. Maritime Silk Road (MSR) project aims to heavily invests in port's internationally to improve connectivity regionally focusing on Central Asia, and multiple researches have been done in this aspect. Major port infrastructures that have been built include Hambantota port in Sri Lanka, Gwadar port in Pakistan and, Kyaukpyu port in Myanmar. Chen et al, 2018 applied a fuzzy clustering model evaluating 14 coastal ports in China using 11 evaluation indexes to determine the existing development conditions of ports and the economic strength of port cities. It highlighted the importance of sustainable developing of China's port and foreign direct investment from China's shipping companies to international shipping infrastructures including terminals and ports, it also concluded that policy makers on the provincial and central level should avoid discrepancies in policy making. Song et al, 2020 proposed a new method named Dynamic Hesitant Fuzzy Bayesian Network (DHFBN) model to determine the way to make a decision of investing in a port under a fuzzy environment. This model emphasizes on the investment focus and the role it makes in international trade, core attributes that are considered in this model include environment risk, social risk, religious risk, cultural difference risk, country's political stability, local infrastructure condition and credit risk. Moreover, Lewis et al, 2021 examined the synergies between China's BRI and objectives of United Nation's (UN) sustainable development goals (SDG). The research concluded that SDG's have influenced the direction of BRI in a few ways especially in sustainable infrastructure development, adoption of more holistic trade and investment strategies and greater openness and inclusive towards non-Chinese and

local business. Development of MRI has significant impact on future sustainable development of a large number of nations and could potentially prosper large spill over effects in the economy.

Coastal ports under the project of BRI have been significant in the economic development of China since the reform of China's open door economic policy in 1979. Port policies have experienced changes though central and local governments over the year and has been heading towards public-private partnership (PPP), the changes in policies have significant impacts of future continual development of maritime industry in China.

There are some research gaps in international port in terms of policy and development over the years and both qualitative and quantitative methods are used to determine the best way of sustainable developing international ports of BRI.

1.2 Literature Review

In the context of the Belt and Road Initiative, Soyres. F., Mulabdic, A & Ruta, M. (2020) propose a structured general equilibrium model to analyze the impact of common transport infrastructure on trade, welfare and GDP. In order to quantify the consequences of ordinary transport infrastructure, they used a quantitative model of international trade based on Caliendo and Parro (2015). They extended this framework in two different directions: 1. Considering the reduction in transport time associated with transport infrastructure. Changes in the cost of trade. 2. Adjust the model to take into account the budget impact of infrastructure projects. In the end the model showed that gross domestic product will increase by up to 3.4 percent for participating countries and by up to 2.9 percent for the world. Because trade gains are not commensurate with projected investment, the model suggests some

countries may be adversely affected by welfare benefits due to the high cost of infrastructure.

Liu, S. Z. (2019) analyzes the factors such as the infrastructure, cargo throughput, service capacity and level of Guangzhou Port, it can be concluded that the current infrastructure in Guangzhou Port is not strong enough to meet development needs, the channel conditions are relatively fragile, and it cannot meet the large-scale development of ships. It also proposed to speed up the construction of Nansha Phase IV, Nansha Universal Terminal, Nansha Ocean Terminal, Nansha Cruise Home Port and the expansion and upgrade of the seaport of Guangzhou Port, to improve infrastructure and navigation capacity, and to meet the needs of large-scale ships. Government departments at all levels to speed up measures to solve the transportation network problems of aviation, railway, highway, and waterway

Wang, D. (2018) uses the factor analysis method to divide the factors affecting port logistics competitiveness into five aspects: infrastructure, operating environment, management status, natural foundation, development scale and development potential. Secondly, the comparative analysis method is used to evaluate each port and clarify the key development direction of the port. Finally, the TOPSIS analysis method is used to carry out weight analysis on the factors affecting the development of the port.

Jihong Chen, Yijie Fei, Zheng Wan, Zaili Yang, Haobo Li, Kyoung-Suk Choi, Xiaoke Xie. study the allometric relationship of an RPC and assesses the port's development potential by achieving three goals.： (1) The first goal is to determine whether there is an all-growth relationship between port cargo throughput (internal

factors) and the number of imports and exports (external factors). (2) The second objective is to calculate the eigenvalues of the allometric growth matrix, including two factors and the development potential of each port in each factor. (3) The third goal is to establish a comprehensive development potential system for RPC ports. This research takes the Pearl River Delta ports in China as an example, and finally concludes that the growth of import and export volume is disproportionate to the growth of port cargo throughput, and the impact of import and export volume on the development potential of the port is greater than the impact of port cargo throughput. In addition, Shenzhen has the greatest development potential in terms of import and export volume, while Zhuhai Port has the greatest potential in terms of port cargo throughput. Finally, an assessment using the Comprehensive Development Potential Assessment System shows that Shenzhen Port has the best comprehensive port development potential.

Peng, X. J. (2019) compares the operating capabilities of various ports from the aspects of infrastructure, hinterland economic development level, government support, cargo throughput, and container throughput based on the actual situation of the Beibu Gulf port group. The relatively weak position after the function positioning, and put forward proposals to strengthen infrastructure construction, improve the economic development level of the port hinterland, and maintain the core advantages of the port to improve the operating capabilities of the three ports.

Yang, Y.H. & Huang, J. H., (2016) compares and analyzes ports by constructing a comprehensive evaluation index system for port logistics competitiveness. Specifically, it uses the principal component analysis method (tested by the KMO method with SPSS software), and selects three representative indicators: Operating scale (cargo throughput, container throughput, port city foreign trade import and

export volume, number of routes), Port logistics infrastructure (number of 10,000-ton berths, storage yard and warehouse area, terminal length, main channel water depth), Port logistics competition Potential (annual average growth rate of cargo throughput, average annual growth rate of container throughput, average annual growth rate of foreign trade imports and exports of port cities, undeveloped coastline resources) to compare the advantages and disadvantages of Shanghai Port and Ningbo-Zhoushan Port, and propose suggestions on integrating logistics and transportation resources and achieving information transparency.

Zhou, Q.U. (2015) uses fuzzy comprehensive analysis to study the three major ports of Shanghai Port, Singapore Port and Hong Kong Port. By comparing and calculating its container throughput, port-city relationship, container handling, infrastructure, and development trends, it is concluded that Shanghai Port has the most comprehensive strength Strong, but the three major ports all have advantages and disadvantages such as good geographical location and advanced facilities. It also proposes the development of the three major ports, all of which should promote strengths and avoid weaknesses. Based on the actual situation and its advantages, it is suggested to improve efficiency and service.

Luo, B.C. (2019) Introduce the main practices and experiences of Singapore's smart port construction. For example, 1. Focus on technology to improve productivity, advance planning and forward-looking layout, and continue to promote terminal automation and intelligence. 2. Committed to advancing the digitalization process and using advanced information technology to improve port operation efficiency and service levels (in the 1980s, the first container terminal operation system (CITOS) was established, and in the 1990s, an interconnected information platform (Port Net) was established) . 3. Strengthen the collaborative

service of port logistics supply chain. 4. Vigorously promote green sustainable development of ports. 5. Actively implement the port ecosystem strategy. Combined with the status quo and future development trends of China's ports, it puts forward suggestions such as changing the development concept, increasing port energy levels, enhancing new kinetic energy for development, promoting comprehensive value chain services, strengthening the strategic awareness of the ecosystem, and creating a good development environment.

Deng, J. F. & Peng, B., (2017) mainly analyse Singapore Port from the aspects of location advantages, policy support, talent introduction, and marine environmental protection, summarizes its successful experience, and makes recommendations for the construction of Ningbo-Zhoushan Port International Shipping Center, such as enhancing strategic determination, and continuing to attach great importance to development. Marine economy and strengthen strategic determination, continue to attach great importance to the development of marine economy.

1.3 Theoretical basis and research method

1.3.1 Literature review

This paper uses Internet resources to search the relevant literature on BRI and port competitiveness, which provides a theoretical basis for the study of this paper.

1.3.2 Factor Analysis

The data analysis methods used in this paper include factor analysis. Factor analysis is a method applied to study the relationship between variables, reduce the

dimension of the complex variable relationship to a few factors, and select the representative factors. In this paper, two common factors are selected according to the results of model operation, and the scores of port competitiveness are obtained.

2. Overview of BRI

2.1 Development of BRI

The Belt and Road Initiative (BRI), which consists of both the Silk Road Economic Belt and the 21st-Century Maritime Silk Road Initiative is a long-term international cooperation introduced by China in 2013. This massive plan illustrated in attachment 1 involves about 65 countries, representing around one-third of the world economy. The emphasis is on transport connectivity and economic cooperation among the involved countries. This paper focuses on the new ocean-based Maritime Silk Road, which is a strategic framework proposing the creation of a more connected trade and economic zone connecting countries in Southeast and East Asia, Africa and the China-Africa-South America (CASA) trading routes are actively being promoted by China (Lee, 2016). Seaports are historically important factor in a country's economic development, which is especially observable as China joined WTO in 2001 and export volumes has increased over the coming two decades (Huo et al., 2019). It helps to strengthen communication in addition promote economic cooperation and the peaceful development of the global economy. The plan of Maritime Silk Road has been mentioned in the 13th Five-year plan where it aims to enhance logistics development and trade facilitation by promoting sustainable upgrade in infrastructure development and facility upgrades in sectors such as maritime transport, intermodal transport and seaports to improve both capacity and capability. Towards this goal, the transport industry is expected to observe a new era of growth in the 21st century. Besides that, the building of free trade zones in these regions for the purpose of improving trade, enhance financial corporation between countries, gain access to

natural resources and to deepen cultural exchanges in the region (OECD Business and Finance Outlook 2018). The total cost for all infrastructure projects as of September 2020 is estimated by Refnitiv (Signed memorandum of understanding or a joint statement if cooperation between countries) to be around $4.3 trillion USD.

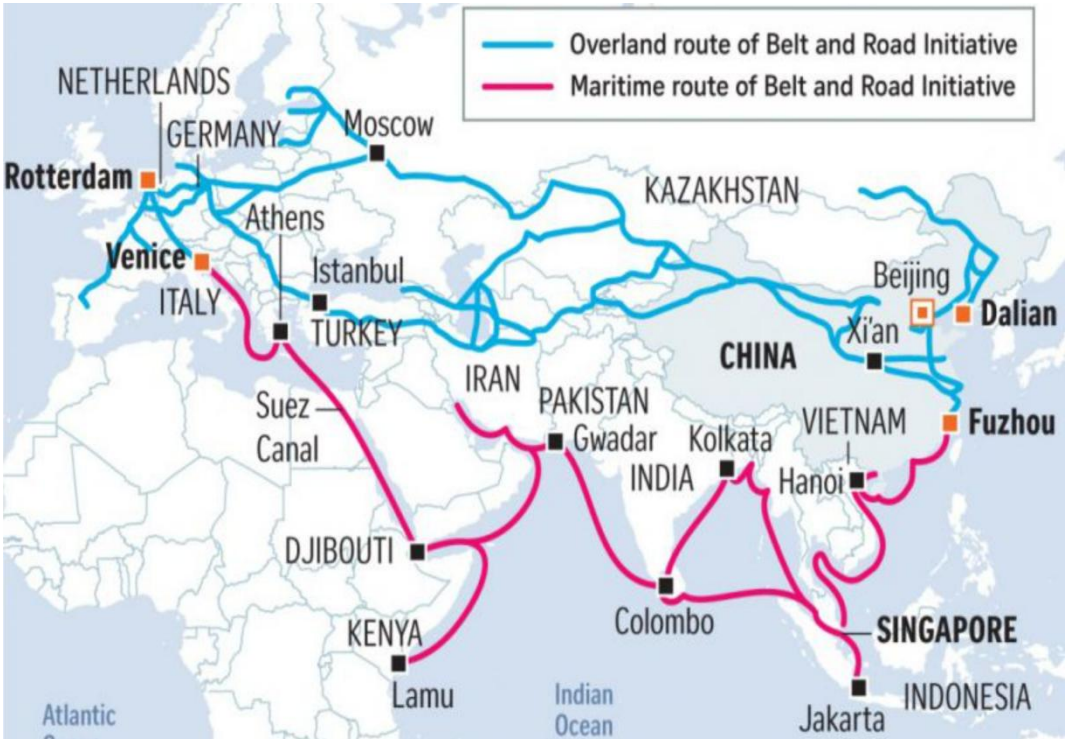

Figure 1, General View of Belt and Road Initiative, Asia Green Real Estate, 2017

Shipping networks and improved connectivity around the vicinity nearby China are fundamental to the new Maritime Silk Road, which is aimed to contribute to promoting international trade and maritime transport. The Maritime Silk Road proposes more direct linkage of Chinese ports with emerging countries and economic regions such as the ASEAN, South Asia, West Asia, North Africa and Europe. Aiming to develop the economic and trade integration of the Asia, Europe and Africa, the Silk Road develops strategic cooperative economic zones oriented to

the South China Sea, the Pacific and the Indian Ocean (Lee et al, 2017). As the connectivity between shipping network is further developed along the proposed Maritime Silk Road, there will be growing demand for shipping links and port networks to improve overall shipping and port industries. China's port connectivity has been growing for the past decades from consistent development in the maritime industry, China has been listed as UNCTAD's highest score in liner shipping connectivity index for several years (UNCTAD, 2021). The ports along the new Maritime Silk Road would expect to see significant potential for future growth, given the anticipation of higher trade volume (Ruan et al, 2018).

However, the BRI project is not free from controversy as this massive project spans over a large area. One widely discussed objective include "predatory lending" whereby the main financial institution behind BRI that is led by China, China Development Bank and Export-Import Bank of China which has lent out huge sums of commercial loans with interest to countries to continents in Asia, Africa and even Europe where they might a high chance in defaulting their loans (Lai, 2020). Countries that have borrowed from China usually require funds to improve their basic infrastructure such as roads and ports but lacks credit which are required from other financial institutions from other countries. These countries usually have large reserves of natural resources or geographically located at very strategic nodes in the BRI project, it is believed that these investments in infrastructure could enable these underinvested countries to be more connected in terms of international trade and would generate economic spill over effects to the BRI project as a whole. However, countries such as Djibouti, Maldives, Laos, Montenegro, Mongolia, Tajikistan, Kyrgyzstan, and Pakistan face problems in repaying debt and the International Monetary Fund (IMF) has come in to help aid in restructuring of debts (Hurley et al,

2021). The capability of repayment of debts heavily relies on the profitability of the infrastructures that are being built and the recent Covid-19 has led China in forgiving large sums of loan repayments in some countries.

2.2 Regional development of BRI

2.2.1 Development of Ports in China

The remarkable growth in China's economy throughout the last few decades has been largely caused by exports from China to other parts of the world, where it was unofficially known as the World's factory. As exports increase, China has heavily invested in infrastructure for ports in coastal regions of China, and China currently has the most concentrated amount of busiest port in the world, occupying 6 out of top 10 busiest ports globally. Port integration and cooperation has become a hot topic in China in the background of slower economic growth, increased competition between the Bohai Rim, Yellow Sea and Yangtze region, port overcapacity and growing international opportunities. The competition and cooperation between Shanghai port and Ningbo-Zhoushan port has attracted the most attention in academia. Individual ports in China are in the more business-oriented competitive environment. They have been strongly encouraged to increase the construction and expand by their local governments due to the key fiscal resource represented within their operational areas (Pallis, Notteboom, & De Langen, 2008). Ports in proximity have been competing fiercely for shoreline resource, hinterland, hubs and feeders and favourite economic policies. As such, the cooperation among competing ports, especially the ports in proximity, is often regarded a practical strategy to avoid the destructive inter-port competition and the disorderly or extravagant planning and construction. The national and provincial

governmental agencies have worked out a number of schemes pertaining to avoiding duplication of facilities, fierce competition and overcapacity in Chinese port system. Development of infrastructure projects along BRI countries could also help solve the overcapacity of China's companies that have seen a decline in demand for development of infrastructure projects.

The introduction of BRI would see an increase in cargo throughput between major ports of China as both export and import volumes are expected to increase throughout the development of BRI project. As ports in China are very different in size and located in geographical region, they serve very different purposes to avoid cannibalism between each other, BRI would enable these ports to rebrand smaller ports by having their infrastructure upgraded. As seaports develop, hinterland development further boosts expansion of dry ports in inland provinces. logistics connectivity of inland provinces is generally positively correlated with the number and the connectivity of the seaports to which they are linked. Win-win cooperative relationships are required to improve the logistics connectivity of inland provinces with respect to not only the logistics conditions, distance, and cost between inland dry ports and seaports but also the required developments and policies of seaports (Wei & Sheng, 2013).

2.2.2 Development of Ports and Ongoing BRI Projects in Asia

This Southeast Asia region has been regarded as a strategic geographical position for both regional and global maritime industry. It includes important straits and four of sixteen strategic seaborne routes in the world (Lombok, Malacca, Ombai-Wetar, and Sunda). In particular, the Malacca Strait is the second busiest in the world (after the Strait of Hormuz. There are approximately 536 ports in

Southeast Asia, where nine of the world's top 50 container ports were located in Southeast Asia in 2020. (Dang, 2017) Most of these ports are able to deal with various types of cargoes and have received the considerable attention from governments regarding their potential for expansionary development. Most countries in this region are middle income in the midst of developing where there is constant growth of population and hence higher demand for goods. This has caused increase competition between ports in South East Asia to be the main transhipment hub in the region such as ports in Singapore, Malaysia (Port Klang and Tanjung Pelepas) and Thailand (Laem Chabang). A list of BRI projects under development in Southeast Asia is as below.

Country	Project	Price (USD Million)
Indonesia	Trans-Sumatra Toll Road	27,700
Indonesia	Sunda Strait Bridge	24,000
Indonesia	Jakarta–Bandung HSR	5,100
Indonesia	Central Kalimantan Coal Railway Network	2,300
Indonesia	West Coast Expressway	2,000
Indonesia	Kertajati Airport	1,800
Indonesia	Soekarno–Hatta Airport Train Express Line	1,800
Indonesia	East–West MRT	1,700
Indonesia	Balikpapan–Samarinda Toll Road	875

Indonesia	Kulon Progo International Airport	700
Indonesia	Surabaya Monorail	558
Indonesia	Kalibaru Port, container terminal	393
Indonesia	Manado–Bitung toll road	330
Singapore	Cross Island Line	21,000
Singapore	Tuas Terminal Phase 1	1,800
Singapore	Singapore- Malaysia High Speed Rail	11,000
Malaysia	Kuala Lumpur Mass Rapid Transit Line 2	6,500
Malaysia	Penang underground tunnel link	2,000
Malaysia	Senai–Desaru Expressway	423
Philippines	Manila–Makati–Pasay–Paranaque Mass Transit System	8,370
Philippines	Bulacan–Laguna rail	4,500
Philippines	North–South Commuter Railway	3,720
Philippines	North–South Commuter Railway south line	3,610
Philippines	Laguna Lakeshore expressway and dike	2,620
Philippines	Redevelopment of Ninoy Aquino International Airport	1,583
Philippines	Manila Light Rail Transit Line 7	1,540

Philippines	Manila LRT Line 6	1,390
Philippines	Manila LRT Line 1 Extention	1,365
Philippines	Philippine Airport package B	1,300
Philippines	Cavite and Laguna Expressway	1,228
Philippines	Mindoro–Batangas floating bridge	1,125
Philippines	Philippine airport package A	1,070
Philippines	Light Rail Transit Line 4	1,065
Philippines	Davao Light Railway Transit	842
Philippines	Davao port reclamation	837
Philippines	NLEX-SLEX Connector Road	578
Philippines	Motor Vehicle inspection System	431
Philippines	Development of Davos Sasa Port	397
Philippines	NAIA Expressway	360
Thailand	Bangkok–Chiang Mai HSR	8,275
Thailand	Bangpa–Nakhon Rachasrima motorway	2,350
Thailand	Blue Line Extention	2,290

Table 1, List of BRI projects in Southeast Asia.

South Asia countries that participate in BRI and signed MOUs with China include Afghanistan, Bangladesh, Maldives, Nepal, Pakistan, and Sri Lanka. This region of Asia is important to the overall development of BRI as this region ranks

lowest in terms of logistics performance and require large investments in infrastructures (Rana & Ji, 2020). Besides that, it is also important for the "String of Pearls" strategy as these countries are very important for development of overall logistical hubs on MSR and move away from their dependence from India (Brewster, 2014). Influential ports in this region include Gwadar port and Karachi port in Pakistan which is part of the China-Pakistan Economic Corridor (CPEC) programme and Hambantota port in Sri Lanka. The development of Gwadar deep sea Port which is developed by China Overseas Port Holding Companies (COPHC) which was leased to China for 40 years starting from April 2013. Hambantota port that is situated in Sri Lanka was one of the first major port projects of BRI that was built in 2017 and was leased to China for 99 years. It is strategically located at the southern of Sri Lanka, overlooking strategic sea lanes over the Indian Ocean. Colombo Port, which is built and operated by Colombo International Container Terminal (CICT) mainly financed by China is another major project in Sri Lanka. Colombo Port is a vital port for transhipment in the region and the volume of cargoes have been increasing after multiple phases of upgrades had been made throughout the years.

A majority of countries in Central Asia are geographically landlocked, hence there are not much development in ports in these areas, which include Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. BRI projects around this region are generally related to land transport infrastructure, such as upgrading of roads and energy related projects for example gas pipelines that run across this region (Aminjonov et al, 2019).

2.2.3 Development of Ports and Ongoing BRI Projects in Europe

Europe have a matured maritime port infrastructure and have some of the busiest international maritime ports such as Port of Rotterdam, Antwerp and Hamburg which are historically important ports around these regions for international trade. China has been the 2nd major trading partner with EU since 2013, and recently became the largest trading partner of China, overtaking USA by having a total of imports and exports amounting to 709 billion USD in 2020 (Eurostat, 2021). The main mode of transport for goods to EU is by road, following by maritime, inland waterways and railway (Eurostat, 2021).

One of the main BRI projects in EU, which is also the Belt in BRI， is a rail infrastructure that is named Eurasia Land Bridge that connects EU to China via Kazakhstan, Russia, Belarus and Poland. Railway freight is relatively more expensive compared to maritime freight, but the transport time for goods is halved and was extremely useful during the Covid-19 pandemic as railway freight volume increased drastically across all 30 lines (DHL, 2021). Besides that, China has heavily invested in major ports of Europe's container terminals as listed in attachment 3. China has heavily invested in EU's major maritime infrastructures, with the total FDI to Europe amounting to around 120 billion euros (European Commission, 2021). The other major investment made to facilitate trade to Europe is the port of Piraeus located in Greece.

Port (Country)	Terminals	Percentage Held by Enterprise
Piraeus (Greece)	Piraeus Container Terminal	COSCO: 100%

Zeebrugge (Belgium)	CSP Zeebrugge Terminals NV	COSCO: 85%
Valencia (Spain)	Noatum Container Terminal	COSCO: 51%
Casablanca (Morocco)	Somaport	CMPort: 49%
Dunkirk (France)	Terminal des Flandres	CMPort: 45%
Vado Ligure (Genoa, Italy)	Vado Reefer Terminal	COSCO: 40%
		QPI: 10%
Bilbao (Spain)	Noatum Container Terminal	COSCO: 40%
Rotterdam (Netherlands)	Euromax Terminal	COSCO: 35%
Ambarli (Istanbul)	Kumport	COSCO: 26%
		CMPort: 26%
Le Havre (France)	Terminal Nord, Terminal de France	CMPort: 25%
Marsaxlokk (Malta)	Malta Freeport Terminal	CMPort: 25%
Marseille Fos (MarseillE, France)	Eurofos	CMPort: 25%
Nantes (France)	Terminal du Grand Ouest	CMPort: 25%
Antwerp (Belgium)	Antwerp Gateway	COSCO: 20%
		CMPort: 5%

Port Said (EGYPT)	Suez Canal Container Terminal	COSCO: 20%
Tanger Med (Tangier, Morocco)	Eurogate Tanger	CMPort: 20%

Table 2, CM ports – China Merchant Port Holdings, QPI- Qingdao Port International Development.

2.2.4 Development of Ports Ongoing BRI Projects in Middle East

Middle East is situated in the crossroads of three main continents, namely Europe, Africa and Asia. Middle East is historically the main exporter of energy (Oil and Liquefied Natural Gas) to China, amounting to 40% of oil imports to the country, where the demand of energy has been increasing in China over the years as countries rely more on exports from China.

BRI related projects that invested in Middle East amount to around $123 billion including 5G projects with all Gulf Cooperation Council countries, with UAE leading the investments. Investments in UAE include an agreement to link products from Aia to Europe via UAE's Trader's Market Station through the port of Jebel Ali. Besides that, a major logistics company in UAE, DP World has signed agreements with China to import, process and pack agricultural products, known as Vegetable Basket. Main maritime related investments include Khalifa port in CSP Abu Dhabi Port which has been operational since 2019. KIZAD Logistics Park is near completion and has attracted a large number of Chinese companies to invest directly in the region. Another major investment in the region is Egypt's Suez Canal Economic zone with a total area of 7.23 square kilometres with a aim to upgrade Egypt as a main hub instead of only being a transit point in the maritime trade.

2.2.5 Development of Ports Ongoing BRI Projects in Africa

China has invested the most in Africa in terms of money compared to other regions, as it lacks basic infrastructure compared to other regions, but they have a large potential as they have a large number of natural resources. Trade relations between China and Africa has increased drastically as trade between them has increased from 1 billion USD in 1980 to approximately 128 billion USD in 2016, and providing substantial amounts of loan amounting to 143 billion USD in loans to Africa mainly to upgrade the existing infrastructure to improve the overall infrastructure and productivity of commercial activities in the region. China has signed memorandums of understanding with 52 out of 54 African countries and the African Union, giving green light to Chinese companies to directly invest in the region. Almost 90% of BRI related projects in African regions is directly or indirectly concerning with energy and transporting of the materials.

The main maritime project in Africa is the revamp of port of Djibouti, where China Merchants group hold a 23.5% stake of a large development project including a free trade zone amounting to around $3 billion. Djibouti's geographical advantage at the traffic heavy red sea waters and Bab-el-Mandeb Strait. This port has faced some criticism as this China's first overseas military base is also based here. There are large numbers of infrastructure projects which include rails and airports in the whole continent of Africa. Another important project in Africa is a power generating hydropower project located in Ghana. Projects to improve overall business feasibility in this region to include building of hydroelectric power plants, including the Souapiti dam in Guinea which is capable of generating 550-megawatt and the Mambila hydro power plant in Nigeria capable of delivering 3,050 megawatts.

3. Influencing factors and evaluation of port competitiveness

3.1 Analysis of Influencing Factors of Port Competitiveness

Port has social attributes acting as an important part of the infrastructure of a country's national economy, and has a very significant regional boundary, which affects development of various social economy. Therefore, port competitiveness involves various aspects of economic development. Besides that, to evaluate the competitiveness of ports comprehensively, we must consider the competitiveness of ports, establishing the evaluation index system, and then carry out quantitative evaluation. Therefore, the analysis of the main factors affecting port competitiveness in the first place. In the real economic life, the impact factor is numerous and complicated, so we're going to classification of influence factors, combined with the existing research literature can be divided into geographical location and natural conditions, the production and business operation ability, three kinds of condition of port hinterland economy, factors and the specific analysis of the construction of the index system for the next step.

3.1.1 Geographical location and natural conditions

One major factor of a port's competitiveness is its geographical location. The competitiveness of a port is mainly reflected in the source of goods in the hinterland and the source of goods in transit, the location of a port will generally consider the level of economic development of the region and proximity to international shipping routes. If a port in the position to meet the first two conditions, then, the

port will have a strong competitiveness and sustainable development ability. If the port is located in a relatively backward area and there is no international shipping route around it, it will be difficult for the port to win the competition even if the port has better technology. This is because, when the cargo owner chooses a port, it is with the goal of minimize transport cost. Long distance transportation on land will not only consume a lot of time, but also increase the cost of transportation. It may also affect the transportation of goods because of the weather. A port with competitive science and technology and intelligent level is higher, can greatly improve the working efficiency, reduce the time of the ship leave port, but still could lead to the overall cost increase, the owner to select the port location is poor, have to face risk of the total cost increase, so the shipper in order to avoid risk, tend to choose port of the geographical position is superior. For a transit port, the international route has a greater impact, because the transit port is responsible for the transfer of goods, which usually carry out long-distance ocean transportation, or the goods are sent to the port along the route from the ocean. Therefore, whether the transit port is close to the international route is very important.

3.1.2 Production and operation capacity

The production and operation capacity of a port shows the capacity of a port to accommodate ships and handle goods at the same time. Loading and unloading rate of a port affects the competitiveness of a port. With the development of ships size becoming larger and larger, the loading and unloading rate of containers is required to be higher. The loading and unloading efficiency of a port has become a concern of shippers. With the increase of transportation cost, large ships are more willing to anchor at feeder ports with high loading and unloading rate, so as to reduce the time

of berthing to increase the sailing time of cargo ships and reduce the cost. Therefore, the loading and unloading rate of the port affects the competitiveness of the port. In addition, no matter what industry now follows the principle of customer first, customer experience and satisfaction directly affect customers' subjective impression and choice of ports. Good management mode will retain and attract more shippers, so the quality of service is also one of the factors affecting competitiveness.

3.1.3 Economic conditions of port hinterland

The economic condition of the port hinterland is affected by many factors, including direct influence to the economic development level of the city where the port is located and the maturity degree of the shipping market. A high economic development level of the city will drive the investment in the port. After obtaining funds, the port can be upgraded and transformed to enhance its competitiveness. The more mature the shipping market is, the better the shipping conditions will be, the lower the shipping cost and the higher the efficiency will attract more goods to choose ports for transportation. Directly affect the port hinterland regional economic level is higher, then prove that the more frequently the production activities, frequent production activities will drive consumption, under the influence of the two together, will make the port for more supply of goods, the production information to the hinterland will deliver products to overseas, so for the judgment of the port economy is not limited to the local GDP, but also to the foreign trade accounts for its economy ratio. The port promotes the circulation of commodities, and only the circulating economy can play the role of the port. The more mature the shipping market, the more complete the supporting industries around the port, the

more perfect the freight network, and the more complete the service Settings, which will reduce the freight cost, improve the efficiency of freight, and ensure the quality of service, which will have a great attraction to the shippers, so that they choose the port to carry out freight.

3.2 Belt and Road port competitiveness evaluation index system

There are many evaluation indexes for port competitiveness. The more the evaluation indexes are, the more the evaluation results can reflect the detailed information of the port. However, due to the lack of port data, it is difficult to collect data, and some indicators have to be abandoned. For example, although the density of highway and railway network in port cities is also an indicator affecting port competitiveness, it is difficult to obtain data. Therefore, some indicators are selected on the principle of easy data access. The hinterland of the port is overlapped and inconvenient to distinguish. The city where the port is located is taken as the research object. In this paper, three first-level indicators and nine second-level indicators are established strictly following the principle of index system construction by reading domestic and foreign literature and based on the analysis of port related basic theories and the actual situation of Belt and Road port development. (Table 3)

First level indicators	Second level indicators
Infrastructure	Number of Berths
	Berth Length
	Maximum Draft
	Infrastructure Index
Operation of scale	Container TEU Handled

Economic indicator	Country GDP
	Country Export Volume
	Country Import Volume
	Political Transparency Indicator

Table 3, Port competitiveness evaluation index system.

3.3 Determination of Port Competitiveness Evaluation Method

Factor analysis method is used to describe the relationship between multiple factors and indicators through a few factors. Thought of this method is to have the same characteristics of variables together, forming a common factor, so that each group of variables is a factor, several factors can use less to replace the more primitive variables, and most of these factors can response the original variable information, this paper uses the factor analysis the main reason by:

(1) The correlation between the two original data is used to reduce the dimension of the complex variables to obtain the simplified structure, and then the common factors are obtained. In order to reduce the influence of subjectivity as much as possible, the variance contribution rate of the weight reuse factor of the index is assigned, so that the evaluation function is more scientific and objective.

(2) Through factor analysis, some key factors can be found out from the complex influencing factors. By analysing the variance contribution rate of factors, the importance of this factor to port competitiveness can be known, and then the factors that have a greater impact on port competitiveness can be known. Based on the analysis of port competitiveness score, the port can find out its own advantages and disadvantages and further enhance its competitiveness.

4. Analysis of Port Competitiveness along the Belt and Road

4.1 Overview of major ports

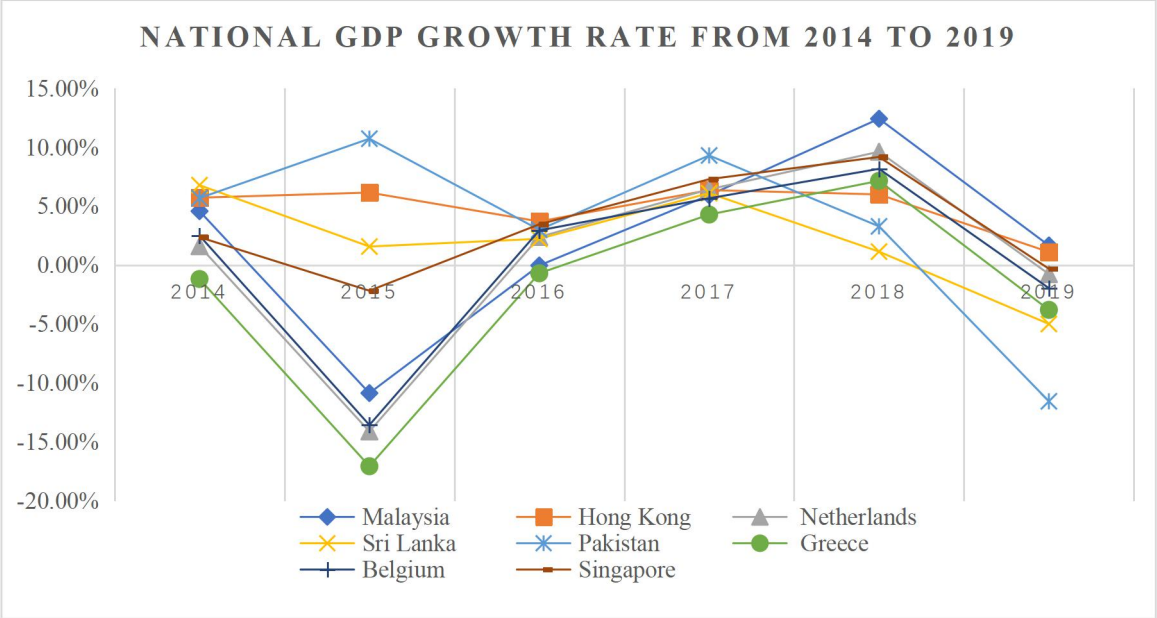

Figure 2, National GDP growth rate from 2014 to 2019

There has been an increase in growth of GDP in the countries listed in above throughout the years since they have been associated with the BRI project. The investments in infrastructures in countries that critically require them have developed growth in economy that could be observed in Figure 2. Most of the countries are reliant on trade in their economy and they require higher cohesive trade relations between each other to help improve their economy together. These countries have been chosen to represent as a sample of the overall population as they are significant maritime trade and overall higher importance in strategy of developing BRI's maritime trade to aid in the successful implementation of BRI.

（1） Port of Singapore

The port of Singapore is located in the southern coast of Singapore, west to the southeast side of the Strait of Malacca, south to the north side of the Strait of Singapore, is the second largest port in the Asia-Pacific region. The port is an important shipping route between the Pacific Ocean and the Indian Ocean and has a very important strategic position. The port of Singapore is also the political, economic, cultural and transportation center of the country. There are six ports in the port of Singapore, namely Sembawang Port, Jurong Port, Pagsanjan Port, Keppel Port, Dan Paug Port, and Blarney Port. Except Jurong Port, which is operated by Yumo Town Authority, the others are all operated by PSA Singapore. There are 96 berths in the port of Singapore, the total length of the coastline is 21.6 kilometres, the maximum water depth is 18 meters, and the vessels with a draft of about 15 meters can enter the port and berth smoothly. In addition to the six port areas, there are two ferry terminals and an international passenger cruise terminal. There are more than 250 shipping routes in the port of Singapore, and more than 600 ports in 123 countries and regions have established business contacts. With advanced port equipment and information management system, Singapore is the most efficient port in the world. When PSA was founded in 1964, it was faced with many hangover from its separation from the Malay Archipelago: Deficiencies of port construction, conflict with Indonesia to make channel security cannot be guaranteed and so on, for potential customers, but the port authority of Singapore through energetically in the development of shipping electronic system, perfect the relevant legal documents shipping process, and the port industry related human resource productivity reform, the crisis into an opportunity, with the help of containerization, the port of Singapore has become an international shipping center.

Since the launch of the Belt and Road Initiative, China and Singapore have become more and more closely connected economically. By improving direct exchange measures of major currencies and promoting cooperation in third-party economic markets, China and Singapore have greatly promoted their economic development. In particular, in recent years, China and Singapore have jointly built a logistics center in Chongqing, which will contribute to the trade and connectivity between western China and ASEAN. Through data analysis, it is found that Singapore's GDP increased by 21% from 3,076 trillion dollars in 2013 to 3,700 trillion dollars in 2019, among which the dividend brought by BRI is not a small number.

（2）Port of Rotterdam

Rotterdam is the second largest city in the Netherlands and the largest port in Europe, located at the confluence of the Rhine and Maas River. It is the largest seaport in Europe and, until recently, the largest in the world. The entire city is spread out on the banks of the Maas River, about 25 kilometres from the North Sea, which is connected to it by new waterways. The port area is deep and wide, inland vessels can pass unimpeded, and the deep-water wharf of the outer port can berth giant freighters and large tankers. Rotterdam is an important port connecting Europe, the United States, Asia, Africa and Australia, known as the "gateway to Europe”. Rotterdam Port is the sea road interchange of BRI. At present, a quarter of the cargo in this port comes from China, and nearly half of China's deep-water cargo routes to Europe make their first stop at Rotterdam Port. In addition, the Chinese investment influence is also rising at the port of Rotterdam, Rotterdam, before the terminal operators are respectively the APM terminals (Maersk's subsidiary), Rotterdam world portal company (Dubai ports world for its largest shareholder) and Hutchison port holdings (ECT) through its subsidiaries in Europe container terminal company.

Hutchison Whampoa operates two terminals in Rotterdam: Euromax and Delta. The two terminals together account for about half of the 14.5 million teu handled annually at Rotterdam, which in itself meant that Hong Kong-based Hutchison Whampoa was the largest container terminal operator in Rotterdam, and the recent acquisition of APM Terminals, a unit of Maersk, it also strengthens China's grip on Rotterdam's port. With the construction of the port area, the current Rotterdam port area has expanded to 12606 hectares, including land area of 7796 hectares and water area of 4810 hectares. With a total of 656 berths and a maximum channel depth of 24 meters, Rotterdam is the port of registry or port of call for more than 500 shipping lines, leading to more than 1,000 ports around the world and accounting for 78% of the total cargo volume of the Netherlands. In recent years, the number of large ships docking at Rotterdam Port also shows an increasing trend.

（3）Port of Antwerp

Port of Antwerp is located in the heart of the European continent, in the lower reaches of the Schelder River, across its banks, 70 kilometres from the end of the North Sea, stretching for more than 20 kilometres. Port of Antwerp is one of the largest ports in the world and the third largest port in Europe after Port of Rotterdam and Port of Hamburg. It is an important hub port: more than 300 scheduled routes serve 800 destinations, providing fast and reliable global connections. Antwerp port hinterland is vast, in addition to the whole Belgium outside, also includes the north of France, France Alsace region, France Lorraine region, Luxembourg, Germany Saarland, Rhine - Main River Basin, Ruhr River Basin and the Netherlands Limburg and other large industrial areas. The Port of Antwerp has a superior geographical location, close to the main production and consumption center in Europe, and is the main shipping cargo distribution and transit center in Europe. Antwerp Port is

famous for the high concentration of industry in the port area, and it is also the petrochemical center in Europe. Over centuries, the port area has expanded to 13,057 hectares, including 7,239 hectares on the Right Bank, 5,818 hectares on the Left Bank and 4,500 hectares on the Watertown. There are more than 20 large and small harbour basins. There are about 1380 hectares of dock area and 3125 hectares of factory area. The total length of berth shoreline is 150 km, more than half of which can receive and discharge Panamax above ships. The Antwerp Port Authority took an active part in the construction and set up a "One Belt and One Road" working group. In addition, Antwerp Port should strengthen cooperation with major ports in China, and sign friendly port agreements or cooperation memorandums of understanding with Shanghai Port, Shenzhen Port, Ningbo Zhoushan Port, Tianjin Port, Qingdao Port and Dalian Port to share relevant information and recommend target customers for cooperation. Antwerp port has achieved remarkable results, China ocean shipping group co., LTD. Has a liner than in shuttling between every week, the group in the port of Antwerp, zebruges port all shares held wharf, thanks to the area, in 2016, the Antwerp port cargo throughput of more than 14.12 million tons from China becoming Antwerp's third largest customer. The two sides are strengthening cooperation in the railway link between the port of Antwerp and western China, which means that the China-Europe freight train from Xining, capital of Qinghai Province in western China, to the port of Antwerp will take about 40 days less than the traditional sea route. In addition, the Chongqing-Antwerp China-Europe freight train has also become a bridge connecting China and Belgium. On June 4, 2010, buhler zhe's institute for international economics, a think-tank in Belgium's official website published a report that the very period of trade and investment relationship was pointed out that "area" initiative to promote trade

between the EU and China and other countries, for the "area" all the way along the country development dividend, is of great significance to the development of global trade. The report also points out that infrastructure projects in countries along the "One Belt and One Road" routes will help reduce the cost of trade in transport and thus increase the import and export volume of relevant countries.

（4） Port of Colombo

Colombo Port, also known as the artificial port of Colombo Port, is one of the largest artificial ports in the world, and also one of the important halfway ports of the world navigation routes in the Eurasian, Pacific and Indian Ocean regions. Port area of Colombo Port covers an area of 24,000 square meters, and there are two port entrances. The water depth of the port is between 9 meters and 11 meters. The port has excellent conditions, which is suitable for docking large and very large vessels. There are three ports in the southwest, northeast and northwest of the port, one facing the sea, which makes it convenient for ships to get in and out. There are Jaye Container Terminals (JCT), Unity Container Terminals (UCT), Southasia Gateway Terminals (SAGT), Colombo International Container Terminals (CICT) and East Container Terminals (ECT) at Colombo Port. As one of the typical successful cases of Chinese-invested operation, CICT has a berth with a water depth of 18 meters and an area of 57 hectares, and a two-way channel with a water depth of 20 meters for the entry and exit channels. It is the only deep-water terminal in South Asia that can handle very large vessels. The container yard at the terminal covers 10 hectares and has 14 container cranes, 45 RGTs and 82 tractors. In 2017, CICT became the first green terminal in South Asia. Its 40 yards and 40 gantry cranes have all been converted from oil to electricity. The CICT terminal's "oil to electricity" project has reduced the terminal's overall carbon emissions by about 57%. CMPH is currently

one of the largest port operators in the world, with a large global shipping network and footprint that enables CICT to effectively integrate into the global shipping market. In addition, CICT can operate 24 hours a week with high levels of productivity, efficiency and reliability. Since 2014, the container throughput of the CICT terminal invested and operated by China Merchants Port has increased sharply, greatly driving the increase of container throughput at Colombo Port. In addition, on January 16, 2019, the 269 hectares of reclaimed land for Colombo Port City project jointly invested by China Communications Construction Co., Ltd. and Sri Lanka was completed, two months earlier than the original plan. This means that Colombo Port City, a key project of the "One Belt and One Road" jointly built by China and Sri Lanka, has made significant progress, laying a solid foundation for the subsequent secondary development. Under the background of One Belt And One Road, China's investment and construction in Sri Lanka has driven the local development.

（5）Port of Gwadar

The port of Gwadar is located near the throat of the strategically important Persian Gulf, straddling several important sea routes from Africa and Europe through the red sea, the strait of Hormuz and the Persian Gulf to east Asia and the Pacific. Gwadar is about 400 kilometres from the Strait of Hormuz, a major conduit for global oil supplies. It started construction in March 2002 and opened to traffic in November 2016. It is a completely Chinese-funded port with both capital and technology from China. It has now developed into the third largest deep-water port in Pakistan. The CPEC starts from Kashgar of Xinjiang in the north and ends at Gwadar Port in the south, which guards the exit of the Strait of Hormuz and is also the geographic intersection point of One Belt and One Road. It has a very important

strategic position. After Pakistan handed over the operation of the port to China Overseas Ports Holding Co., Ltd. in 2013, the port has become the hub and soul of the entire China-Pakistan Economic Corridor.

（6）Port of Hong Kong

As the earliest shipping center of China - Hong Kong, although belongs to China, but because of the policy of "one country, two systems", has made Hong Kong remains the nature of capitalism, and on the premise of one China, a high degree of autonomy, so in the discussion, will it as a foreign city category to discuss, but even this kind of situation, development of Hong Kong's shipping industry is still of high research value. Hong Kong is a natural port of China and a shipping center for the Far East. Hong Kong is located at the crossroads between China and neighbouring Asian countries, at the entrance of the Pearl River Delta and at the centre of the Asia Pacific region, where economic growth is booming. Hong Kong is one of the busiest and most efficient international container ports in the world and a major hub port in the global supply chain. At present, there are more than 80 international liner services providing about 500 container liner services per week, connecting Hong Kong to more than 500 destinations around the world. Hong Kong is one of the busiest and most efficient international container ports in the world, handling 22.2 million standard containers (TEUs) in 2014.At present, the port of Hong Kong provides about 350 container liner services every week, connecting the port of Hong Kong to some 510 destinations worldwide. Major cargo handling facilities at the port include the container terminal, river trade terminal, mid-stream working area and public cargo working area. Support facilities include docks, typhoon shelters, etc. Hong Kong has four unique advantages in the construction of "One Belt and One Road", namely location, pioneer, service industry specialization

and cultural culture, so it can play an important role. Located on the busiest international shipping route in the world, Hong Kong has a developed port economy and is an important gateway to China's opening-up. On land, Hong Kong is backed by Guangdong. With modern connectivity, Hong Kong has convenient, efficient and low-cost access to the mainland. It is an important node connecting the land and the sea and the rest of the world.

（7）Port of Piraeus

Piraeus port is located in the southeast coast of Greece nou nico bay shore, southwest near the Aegean Sea, the port is the ship through the Mediterranean to the Atlantic, through the red sea to the Indian Ocean, through the sea of Marmora to the black sea, connecting the Balkan peninsula in Western Europe, southern Europe, the black sea region, central and eastern Europe, the Middle East, Africa, transhipment port. It is the largest port in Greece and one of the top ten container terminals in Europe. In the open sea before take over, Piraeus port is a purely local, moored in the ships are in Greece as the destination, but China’s shipping company, COSCO Shipping have obtained a 35-year concession in 2008 and further obtained a controlling stake in 2016. Port of Piraeus is geographically advantaged as a transhipment port to Europe, and the volume of cargo has increased drastically and handled 5.44 million TEU in 2019, representing an increase of 15.1% year on year placing it at the 4th busiest port in Europe in 2019.With the help of Chinese capital and management experience, Piraeus Port has been reborn and achieved rapid development achievements. Today, Piraeus Port has become an important hub port in the Mediterranean region, a One Belt And One Road "Blue Economic Channel" and a flagship project of the One Belt And One Road jointly built by China and Greece.

（8） Port Klang

Port Klang is located at the mouth where the Klang River flows into the Strait of Malacca. It is about 38 kilometres away from Kuala Lumpur, the capital of Malaysia, and belongs to the outer port of Kuala Lumpur. Port Klang has excellent infrastructure and has formed a three-dimensional transportation and logistics network of roads, railways, air and waterways. In terms of waterways, Port Klang consists of three ports, namely West Port, North Port and South Point Port. West Port, which deals with container cargo handling, is complemented by North Port, which focuses on international transit cargo, and North Port, which focuses more on regional transit and local cargo. BRI projects are heavily invested in Malaysia include the Melaka Gateway project and upgrade of Kuantan Port which would help increase the throughput of containers in Port Klang. A new project called the Carey Island project aimed to improve overall functionality of port Klang and a new proposed free trade zone. Feasibility studies of this project is ongoing and this project will have large potential of improvement as this project is proposed to be able to handle 30 million containers annually. BRI project would improve the volume of cargo going through the South China and hence subsequently benefit further development of Port Klang.

4.2 Port competitiveness based on factor analysis

Variables that are used in the principal component analysis is depicted below. These variables are selected base on criteria to measure each port’s competitiveness.

Name	Factor/ Port	Unit
Var 1	Political Transparency Indicator	Index
Var 2	Container TEU	Million Tons
Var 3	Number of Berths	Unit
Var 4	Berth Length	Kilometers
Var 5	Maximum Draft	Meters
Var 6	Country GDP	Billion USD
Var 7	Country Export Volume	Billion USD
Var 8	Country Import Volume	Billion USD
Var 9	Infrastructure Index (LPI)	Index

Table 4, Variables used for Principal Component Analysis

After performing principal component analysis using SPSS, communalities which is the proportion of each variable's variance that can be explained by the principal components, also noted as h2 and can be defined as the sum of squared factor loadings is shown in table 5. The extraction volume on the right indicates each variable's variance which have are around 90%, which indicates that it is well represented in the common factor space.

Factor	Initial	Extraction（%）
Political Transparency Indicator	1.000	0.731
Container TEU	1.000	0.863
Number of Berths	1.000	0.547
Berth Length	1.000	0.775
Maximum Draft	1.000	0.551
Country GDP	1.000	0.886
Country Export Volume	1.000	0.897
Country Import Volume	1.000	0.820
Infrastructure Index	1.000	0.911

Table 5, Communalities

Using factor analysis method and orthogonal rotation of maximum variance, the constituent factors of each index are obtained. The extraction of effective factors was based on the principle that the characteristic root was greater than or equal to 1. Two factors were finally extracted. The eigenvalue of factor 1 was 3.959, and the variance contribution rate was 58.938. The eigenvalue of factor 2 was 3.022, and the variance contribution rate was 18.627. The cumulative variance contribution rate of the two factors was 77.565%, which could explain the total variance of 77.565%. See Table 6 for detailed analysis results.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotated Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	5.304	58.938	58.938	5.304	58.938	58.938	3.959	43.992	43.992
2	1.676	18.627	77.565	1.676	18.627	77.565	3.022	33.573	77.565

Table 6, Total Variance Explained

As seen from the gravel diagram in Figure 3, the larger the slope at the inflection point is, the stronger its ability to interpret the original data is. It can be seen that the slope of the line segment before the inflection point of the second principal component is high, while the slope is obviously zero after it, indicating that the first two principal components can explain all the original data. Therefore, it is feasible and meaningful to extract two principal components in this method.

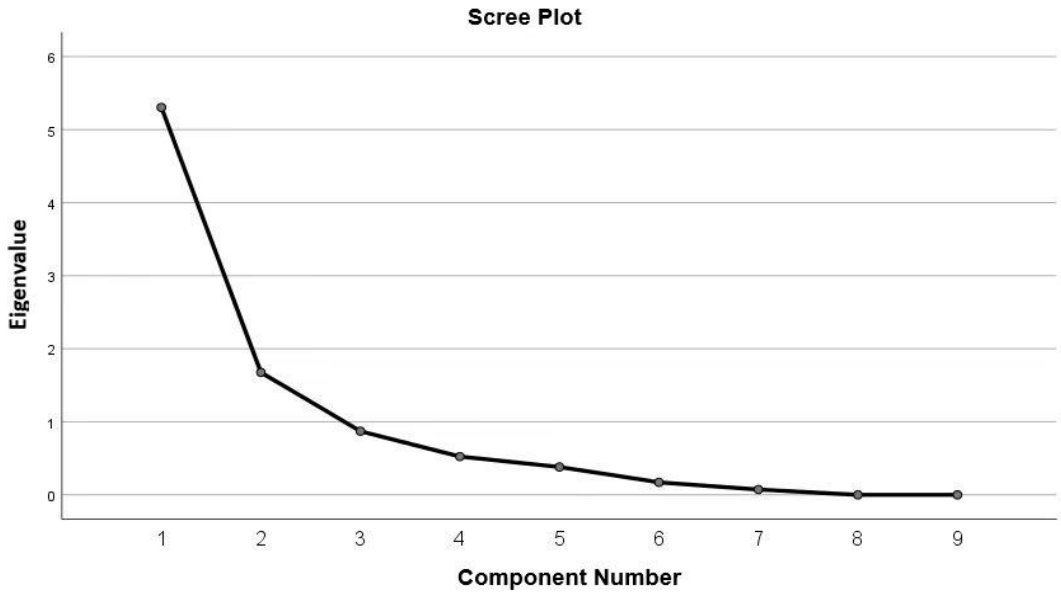

Figure 3, Scree Plot

The load matrix after rotation is shown in Table 7. Two factors are finally extracted, which can explain 77.565% of the total variance. The index whose absolute value is greater than 0.6 is selected. Among them, Political Transparency Indicator, Country Export Volume, Country Import Volume and Infrastructure Index. The large load on factor 1 can be classified as factor 1; Berth Length, Maximum Draft and Country GDP has a large load on factor 2, which can be

classified into factor 2. According to the two common factors extracted above, the common factor scores of each index were obtained by regression method, and each region was ranked according to the common factor scores. See for detailed analysis results.

Component	1	2
Political Transparency Indicator	0.795	0.314
Container TEU	0.919	-0.135
Number of Berths	0.459	-0.579
Berth Length	0.271	0.837
Maximum Draft	0.188	0.718
Country GDP	0.480	0.810
Country Export Volume	0.793	0.519
Country Import Volume	0.744	0.516
Infrastructure Index	0.866	0.401

Table 7, Rotated component matrix

Ports	Factor One score	Ranking	Factor Two score	Ranking
Port of Singapore	1.638	1	-0.946	7
Port of Rotterdam	0.493	2	2.030	1
Port of Hong Kong	0.465	3	0.237	3
Port of Antwerp	0.336	4	0.504	2
Port Klang	0.244	5	-1.033	8
Gwadar Port	-1.523	8	0.203	4
Port of Piraeus	-0.808	6	-0.315	5
Port of Colombo	-0.845	7	-0.682	6

Table 8, Ranking by ports

The F1 capability factor, which accounts for 43.99% of the comprehensive competitiveness, has the greatest impact on the comprehensive competitiveness of the port. Singapore, Hong Kong, and Rotterdam scored higher, indicating the port infrastructure conditions in the economically developed areas. Compared with

Piraeus, Colombo, and Gwadar, these areas with lower economic levels are more economical. superior. Therefore, the development of ports in economically developed areas should focus on smoother trade agreements and increase the circulation of technology and cargos.

The F2 capability factor accounts for 33.57% of the overall competitiveness, which has a greater impact on port competitiveness. It can be seen from the ranking that some ports have obvious geographical advantages, such as the Port of Antwerp and Gwadar. Therefore, for these ports with superior geographical location but insufficient operating capacity, it is necessary to improve their infrastructure conditions and give full play to their location advantages.

5. Conclusion and Suggestions

5.1 Conclusion

From the analysis above, we could conclude that the factors that have higher weightage include container TEU, political transparency indicator, infrastructure index and export and import volume, country GDP and number of berths in port. This would indicate different level of importance that should be reviewed when developing a port in BRI related countries. As BRI is an intraregional infrastructure project expanding over a large area that emphasizes a lot on logistics and supply chain based on the maritime trade, different trade policies between countries would have to increase the frequency of trade in the regions nearby BRI countries. As trades becomes more globalized, and with maritime trade consisting of approximately 70% of global trade projects, major investments are required to facilitate trade and trade agreements between countries and regions should be well established to ensure a win-win situation for all countries that participate in the BRI project. Certain ports are based in countries which have very advanced and developed economies with higher GDP per Capita and buying power such as Singapore and Netherlands and they usually have well established port infrastructure to accommodate trade, but the room for further development of port is comparatively limited compared to developing countries in South East Asia such as Sri Lanka and Malaysia which are very well placed geographically on maritime trade chokepoints. Developing countries often lack funding from major international financial institutions as they might be seen unattractive as an investment for them or lack the required credit to obtain loans to improve their overall country's basic infrastructure although they have a large and young workforce, as could be

observed in the case of Africa. Political transparency plays a huge role in determining which countries should receive such loans related to BRI as corruption or political instability would deter the development process of the country. A transfer of skill is required to these countries as they further develop to be more productive in improving the overall international trade. Infrastructure of ports such as number berths, depth of draft and TEU capability could directly reflect the education and level of skills of a nation as after they are built, they are required to be maintained and managed by locals, where a BOTS (Build, Operate, Transfer Scheme) would be beneficial for all parties as ports are the bottlenecks of how large a ship could be. As container vessels try to achieve better returns from scaling, larger container vessels are being built, and only countries with the best port infrastructure would be able to facilitate these vessels, and hence other ports in the region might face huge competition and might receive lower cargo in the long run.

From the Factor one score, we could observe that port of Singapore, Rotterdam and Hong Kong are ranked as the top 3, as they have a long history of maritime trade and hence have a port infrastructure that are better compared to others. They have established trade regulations that are more attractive for them be port of calls in the region such as free trade zones and trade agreements. Ports include Gwadar, Piraeus and Colombo are at the lower end as they are developing countries and have more room to growth in their trade. These ports are situated in geographically advantaged countries with a advantage of lower labour cost

5.2 Suggestions

5.2.1 Strengthen intergovernmental international cooperation and build a top-level design for bilateral port cooperation

Port is the 21st century, the Belt and Road Initiative to promote the implementation of the key to the carrier, is to strengthen the area all the way along the national infrastructure interconnectivity of important node, improve the comprehensive competitiveness of port area all the way along the country, to promote bilateral port cooperation, by strengthening port cooperation between governments, set up the top of the bilateral port cooperation planning and design. Enhance the comprehensive competitiveness of ports, strengthen bilateral port cooperation, take the national government as the main body, and rely on the leading construction enterprises and port operation enterprises. At the level of BRI countries, through the signing of bilateral cooperation documents between governments, set up a general guideline for BRI port cooperation. Relevant industrial associations and institutions have issued industrial norms guidance documents, such as investment guidelines for the port industry, cooperation norms for infrastructure projects and other professional norms, to guarantee the cooperation of bilateral enterprises along the Belt and Road by industrial norms. Relevant legal organs of countries along the Belt and Road have issued relevant laws and regulations to remove barriers to bilateral port cooperation and ensure the sustained and effective outcomes of cooperation. Enterprise level, the leading infrastructure companies, port operators are the important chance to seize the national maritime silk road initiative, actively planning, improve port infrastructure, port operations overseas, overseas port construction projects such as layout, strengthen the contact area all the way along

the communication port state, build system of port at the top of cooperation between enterprises, in order to further improve the comprehensive competitiveness of ports, deepen bilateral ports To lay a solid foundation.

5.2.2 Strengthen the construction of port infrastructure and improve port operations

Port hardware infrastructure level is an important index to measure the competitiveness of port, is the basic elements to carry out the port production and operation, to strengthen the construction of port hardware infrastructure, improving the comprehensive competitiveness of port, to the government as the main body, port construction enterprises, and communities for the implementation of the government on port development macroscopic planning file specification as an opportunity, increasing financial investment, Port infrastructure for a targeted promotion plan, in port operations loading and unloading machine number, channel number, channel depth and dock berth number, warehouse yard area of infrastructure to improve the improvement, such as planned and have layers, all-round to improve port infrastructure and port operation mechanism of enterprise through the establishment of cooperation with overseas port, with the aid of the port infrastructure projects, equity participation, Gwadar Port cooperation should be carried out in the form of port investment, relying on foreign capital and technology, upgrading port hardware and infrastructure, referring to advanced port operation and management concepts, and comprehensively improving port hardware and infrastructure and port operation.

5.2.3 Raise the level of port technological operations and build a new generation of smart ports

Comprehensive competitiveness of the port operation level of science and technology is the important factor that Belt and Road Initiative along the country to improve the comprehensive competitiveness of ports, port need increase investment in science and technology, the port operation equipment upgrade technology upgrading, a large number of high intelligent automation equipment, new technology and new concept, with "+" Internet "wisdom", "big data" a new generation of intelligent Network data to build an intelligent port. At the same time, improve the level of intelligent port technology, port enterprises to rely on colleges and universities, research institutes and other professional think-tank power, strengthen the manufacture-learning-research cooperation, using the latest technology, the latest idea to raise the level of port wisdom, on the other hand, through technical training, enhancing the technical levels of port operations personnel, improve the efficiency of port operation, port operations management enterprises to attach importance to foreign exchange, through port alliance with a area all the way along the famous port development mechanism, intelligent for port operation technology, facilities upgrading, the technical workers operating training content such as regular communication, draw lessons from the advanced, actively build port development expert team and think-tank strength, strengthen the operation and new technology to use the research of port, forecast port industry development model, demonstrated and first Improve the port operation monitoring and statistics, strengthen the analysis and application of statistical data, forecast the development trend of the industry, and lead the development direction of the industry.

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